Radiation estimates related to the Energy Recovery LINAC facility in Bldg. 912

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This is an attempt to describe briefly about the radiation estimates that I have made for the Energy Recovery LINAC (ERL) facility in Building 912.

1. Assumptions and parameters

The ERL in the simulation is a rectangular room with dimensions 29′ (width) × 53′ (length) × 9′ (height). This may not be the final dimensions but I did not bother to change once I started to do the radiation simulation/calculation a few months ago. The distance of the beampipe from the wall is 53″ and is parallel to the wall. This facility is covered by 4′ concrete on the four sides and 2′ concrete at the top.

The following is the scenario which would give the most radiation:

- Electron beam current of 0.5 A
- Max. loss of 0.4% (0.4% × 0.5 A = 2 mA)
- Electron beam energy at 54 MeV

It is said that the chronic loss is ~1000 times less than the above.

Individual devices can be shielded by local shielding (if necessary). The most problematic source radiation is from beam scraping at the beampipe which goes around the entire facility. The beampipe used in the simulation is steel and cylindrical in shape with a radius of 1.5 inch and thickness of 1/8 of an inch, which may not be the final dimension of the beampipe either.

The simulation software used is MCNPX with the newest version 2.5e, at this time.

2. Results

The beam is assumed to be scraping at the edge of the beampipe. Detector tallies in MCNPX are used to find the fluences and therefore the dose rates under various conditions.

- The distribution of the radiation due to beam scraping has been found to be the highest outside the side of wall which is closest to the beampipe. (Obviously!)

- Directly from the MCNPX, just outside the side walls, the photonuclear contribution (i.e., neutrons) to the radiation is typically ~1000 times smaller than the photon contribution.

- With 4 ft of concrete shielding at the side, the equivalent doses (or simply called doses) with or without a 10 cm lead cladding and with light or heavy concrete, are tabulated as follows:

	Highest dose rate at the side (rem/electron)	**Highest dose rate at the side (rem/hour)**	**Error**
no lead, light concrete	**3.5E-20**	**1.57E+00**	**25%**
lead, light concrete	**5E-21**	**2.25E-01**	**100%**
lead, heavy concrete	**2E-23**	**8.99E-04**	**100%**

- With 2 ft of shielding at the top of the ERL, the skyshine near the ceiling of the Bldg. 912 which is assumed to be 25′ from the floor is about ??. This number comes from direct or brute-force simulation by MCNPX using point detector and filling the space between the ERL and the ceiling with air of density 0.0012 gcm^{-3}. Here, the photonuclear contribution is significant.